# HAM RADIO

**By Peter N. Spotts**
Staff writer of The Christian Science Monitor

**Boston**

The recruiting poster of the 1980s could read: US high tech firms want YOU!

The big question: Where will the "YOUs" come from?

Wayne Green says he's got a good handle on the answer — many recruits for the high tech competition with Japan and Western Europe will come from among the ranks of young amateur radio enthusiasts.

"Between World War II and 1963, amateur radio grew at a steady 11 percent a year. Seventy-five percent of those new amateurs were teens, and of that 75 percent, 80 percent went into electronics as a career," says Mr. Green, a licensed amateur (ham) radio operator since 1939 and publisher of 73, a monthly amateur radio magazine.

David Sumner (K1ZZ), general manager of the American Radio Relay League (ARRL), the national organization for ham radio buffs, says currently about half of the amateur radio operators licensed prior to college wind up in careers related to electronics.

"Considering the challenge to the United States in high technology fields, it's important to give kids hands-on experience in electronics," he says.

It's the tinkering behind the screens and cabinets that some observers say sets ham radio apart from home computers as a means of whetting people's appetites for careers electronic.

"The computer craze might teach young people how to play Pac Man, but it's shallow. It won't teach them how computers work electronically," says William Orr (W6SAI), a licensed amateur since 1934 and a recognized authority on ham radio.

In large part, this may be due to the fact that it's relatively easy — assuming one has the money — to become a computer operator. One walks into a computer store, listens to a sales pitch, says "I'll take that one," then takes it home and plugs it in.

Hams must pass exams that include extensive sections on radio theory before they can pocket the required operating license. Once the "ticket" arrives in the mailbox, the ham often feels an urge to put theory into practice — and that leads to tinkering.

A study of ham radio conducted in 1980 by the Institute for Social Research (ISR) at Florida State University notes that

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32 percent of the hams surveyed averaged one-to-two hours a week experimenting with, building, or repairing their radios; 13 percent spent three to eight hours a week; and 7 percent spent more than nine hours a week. Put another way, slightly more than half the amateurs polled spent an hour or more a week behind a screw driver or soldering iron.

One technique that's tweaked the interest of between 400 and 500 hams worldwide is Earth-moon-Earth (EME) communications — known in the jargon as moonbounce. Signals on VHF, UHF, and microwave frequencies — once thought useful only for line-of-sight communication — are bounced off the moon's surface for transcontinental and overseas contacts.

"When I got into ham radio, I was looking for something different," says Ken Kucera (KA0Y), who was first licensed in 1977. He says he found that "something different" in EME work.

A monument (of sorts) to his interest rests on a small mound in front of his home, a 300-acre grain and livestock farm near Riverside, Iowa. There, atop a modified, 10-ton surplus Navy gun mount sits a homemade, 42-foot diameter dish antenna. It took about three months and 14,000 POP rivets to build. When the time came to mount it, Mr. Kucera says he got help from members of a local amateur radio club — a high tech barn-raising. The antenna is fully steerable, so it can track the moon as it crosses the sky.

The dish is as much a monument to hamdom's traditional penny-pinching image as it is to moonbounce. Kucera says he got the gun mount from the University of Iowa in exchange for building a storage shed for the astronomy department. He purchased a special type of transmission line he needed second-hand.

Kucera uses homemade receiver preamplifiers and transverters in conjunction with a commercial transmitter and receiver. The transverters allow his store-bought radio to operate on frequencies it wasn't originally designed to use. The preamps boost his receiver's ability to dig weak signals out of the background noise — a vital characteristic for EME work.

What kind of contacts can be made using EME? "I've worked all states on 2 meters, and I've probably got 35-40 countries on 432 [MHz], " he says. "Lots of Europeans, Russians, and Australians use moonbounce."

It's probably becoming clear that there is a vast difference between ham radio and citizens band radio (CB), which exploded in popularity during the late '70s.

"CB is for personal and business communication. There's no examination to get a license, though you have to be 18 years old to apply for one. And communications are limited to 40 channels and a 150-mile radius," says John Small, with the Federal Communications Commission's (FCC) personal communications bureau in Washington, D.C.

Amateur radio "is purely for contacting other hams worldwide — no business communications — and for technical experimentation. Hams have to pass [International Morse] code and radio theory exams to get a license, and they have a broad spectrum of frequencies to use," he says. Those groups of frequencies extend from just above the AM broadcast band well into the microwave region.

The distinctions don't stop there. CB communication utilizes voice, and the power limit on a CB transmitter is about 5 watts. Hams use voice, Morse code, radio teletype, television, as well as satellites, moon-bounce communication, and repeaters. The power limit for ham transmitters in the US, with some exceptions, is 1,000 watts.

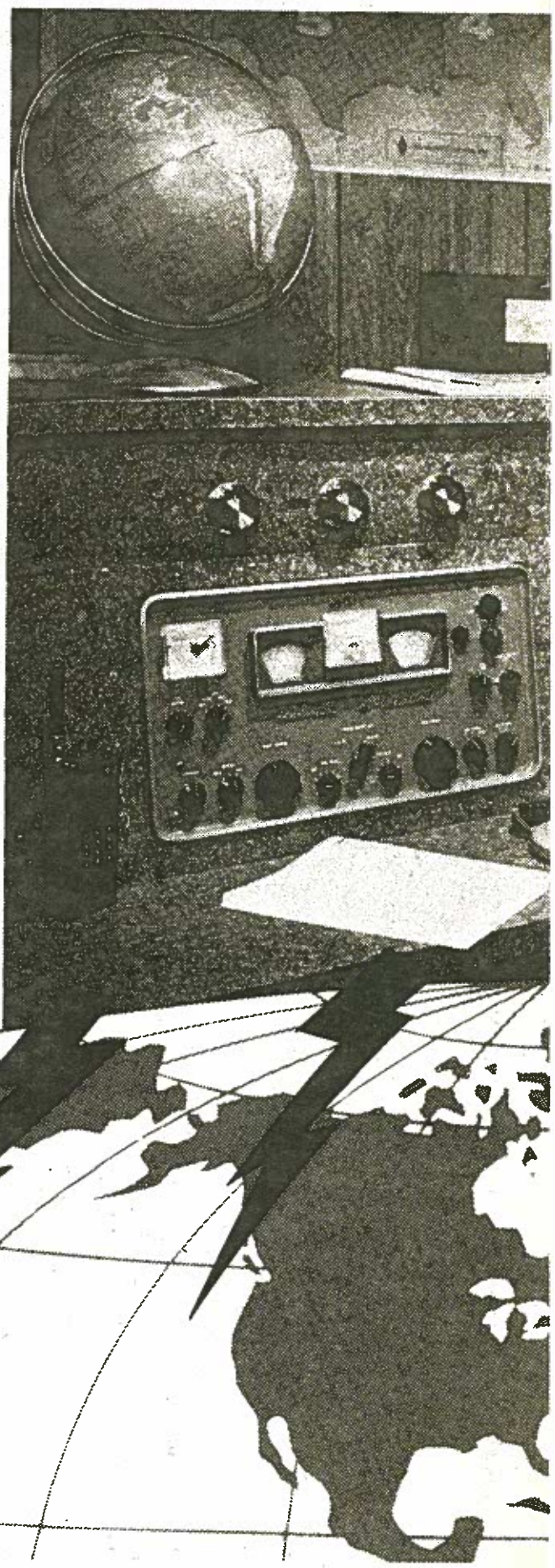
Like CB, amateur operators are issued a call sign, which by law they must use when operating to periodically identify their stations.

Amateur radio traces its roots back to the days before Guglielmo Marconi's famous transatlantic "S" reached St. John's, Newfoundland from Poldhu, Cornwall by wireless in 1901. Prior to that time, hundreds of young people were experimenting with electric motors, wet cell batteries, and neighborhood telegraph systems. When Marconi's feat hit the papers, it set these backyard experimenters to fiddling with the newfangled wireless.

Currently, the US sports some 400,000 "hams." They collectively spend between $100 million and $200 million a year on transmitters, receivers, and a host of electronic parts and accessories. Based on the ISR study, the "average" ham radio operator in the US in 1980 was male, about 46 years old, was likely to have a college degree, an annual family income of nearly $30,000, and spent about $301 that year on amateur radio. The total investment in his station: $1,668.

But amateur radio needn't be expensive. It's possible to spend less than $100 for equipment to get on the air. Thirty-seven percent of the amateurs surveyed by the ISR had family incomes of less than $20,000 a year. Amateur ranks are filled with junior high and high school students, senior citizens, truck drivers, housewives, and career women. Even pre-schoolers get into the act. The youngest person to qualify for an amateur radio license in the US, Guy Mitchell (WD0DVX), did so in 1977 — 15 days before his fifth birthday.

In giving it's formal nod to amateur radio, the FCC out-



# A GLOBAL LINK IN A DIVIDED WORLD

lined the reasons for allowing the service to exist: its unique ability to enhance international cooperation and understanding through one-on-one contacts with hams around the world, and its public service and technical contributions.

"If you're a radio amateur, it gets to be an open door" traveling overseas, says Mr. Orr, who's visited many of the overseas hams he's "worked." But he says one of his favorite traveling-ham stories involves a friend who spent time in Yugoslavia on business.

"This guy went to a lot of trouble to get a Yugoslavian amateur radio license. When it finally came, he asked his landlady if he could put a simple antenna on the roof," he explains.

" 'No you can't,' she replied. 'I don't want anyone up on my new slate roof!' Well, my friend went to a local ham club meeting later that week, and during the course of the evening was chatting with a few of the local amateurs and told his story.

" 'Don't leave without me!' one of them said. After the meeting was over, this fellow put on his secret police uniform and went with my friend to have a chat with the landlady. He pounded on the door with his truncheon, and when the landlady opened the door, she nearly fainted!

" 'Police!' the officer growled. 'We want to put an antenna for one of our radios on your roof!' My friend was on the air not long after."

Underneath the camaraderie, however, lie crucial differences in how ham radio is viewed by its nearly 2 million adherents worldwide.

The ARRL's Sumner says, "The West sees amateur radio as an individual, leisure time activity that involves interpersonal communication, experimentation, emergency communications, things like that. In Eastern Europe, the focus tends to be more on the training of operators and technicians and group activities, rather than on the individual. In the USSR, there is a definite link to the military. Soviet hams are part of DOSAF, the Committee to Provide Assistance to the Armed Forces."

(In the US, hams provided a pool of operators from which the military drew radiomen during both world wars. Many US hams participate in MARS — the Military Affiliate Radio System. MARS operators pass messages for the military, usually of a personal nature. During the Vietnam war, according to QST's senior technical editor Doug DeMaw [W1FB], the US Army spotted a design for a simple, low-power transmitter in QST magazine and asked the ARRL if it could duplicate it for use in a throw-away field transmitter. And federal emergency planners are said to be assessing the role amateur radio operators could play in rebuilding key communications links in the event of a "national emergency.")

In the third world, says Sumner, amateur radio "tends to be confined to the economically well-off."

Much amateur radio's support in the US stems from its public service contributions. These activities include providing communications for marathons, parades, golf tournaments, and other public events. Many of the amateurs most effective during these events cut their teeth on networks organized by the ARRL to relay personal messages for the general public free of charge.

But in the long run, the value of these nets lie in their ability to train efficient communicators. The discipline inherent in net operations pays off during emergencies.

"A classic case involved an outbreak of tornadoes on April 2 [1982] in northeastern Texas — particularly the city of Paris," says Larry E. Mooney (WB5PWY), regional preparedness meteorologist with the National Weather Service (NWS) in Fort Worth, Texas.

A severe storm produced seven tornadoes as it moved through the area. Hams trained as tornado spotters located the twisters, began chasing them, and radioed their approximate speeds and directions. One bore down on Paris, a county seat with "roughly 30,000 people."

"The city doesn't have a siren system. Instead, they run ambulances, fire trucks, and police cruisers through the city with their sirens on. Paris had 30 minutes' time to send cruisers throughout the city," he says. "They wouldn't have had that time without those amateur radio operators."

"One of the amateurs tried to catch the tornado but couldn't. . . . But he was the first to arrive in Paris after the storm hit. The city's communications were out, so he set up a station, relayed damage reports, and called for blood supplies and ambulances," Mooney says.

"In this case, amateurs were very important. There's a gross misconception that radar will detect tornadoes. But that's not really true. We watched that storm, but we had no way of knowing it was tornadic. The kind of 'ground truth' data provided by amateurs is very important. As a service organization, we're to the point now where we have serious problems: We've got to serve a growing population with a small staff. We couldn't function without help from amateurs," he says.

Public service may be amateur radio's most visible role. But the FCC also has stressed the service's role as a training ground for technicians or as laboratory — a low-cost one at that — for advancing the state of the art in radio communication. (Not to mention advancing movie props: The "phone home" communicator in last summer's hit film "E. T." was designed and built by Henry Feinberg [K2SSQ].)

Two of the more exotic "media" for that art are:

● **Satellites.** Known as OSCAR (Orbiting Satellite Carrying Amateur Radio), amateur satellites have been aloft since December 1961. Out-of-pocket expenses — excluding launch costs — for OSCAR I were $61.67. The simple satellite was built in basement and garage workshops by hams who also were engineers with the US space program. OSCAR VIII, the latest US amateur satellite in orbit, was built by the Amateur Radio Satellite Corporation, a non-profit group of hams, under tightly controlled conditions "equivalent to anything that [now] goes into space," says ARRL spokesman Peter O'Dell.

It cost about $60,000 — roughly 3 percent of the $2 million it would have cost to build it commercially. OSCAR VIII has been joined by six Soviet ham satellites and one from England. Aside from giving hams another outlet for their urge to communicate, OSCAR satellites have served as "live" subjects for science classes in elementary schools, high schools, and colleges. The experiments have included plotting orbits and decoding satellite telemetry.

● **Packet radio.** Hams are taking packet switching, a computer-based technique designed originally for use along phone lines, and adapting it to radio. A packet is a short message sandwiched between a header and a trailer. The header gets the message where it's going, and the trailer controls errors. When used with VHF/UHF repeaters — basically remote radios that relay signals — packet techniques allow repeaters to handle more messages at a faster pace than they currently can. Currently if someone sends a message, the channel is tied up for the length of the message. If the message gets garbled, the whole text has to be resent. Packet radio breaks a message into a group of mini-messages. These are sent when the frequency is clear — even if only for a few seconds between someone else's packets. The headers and trailers ensure that the packets arrive in the right order to reconstruct the entire message virtually error-free.

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## How to go about setting up the equipment for your first station

*Second of three articles on how to become an amateur radio operator*

**By Peter N. Spotts**
Staff writer of
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Once you've passed the novice-license test, it's time to start thinking about setting up your first station.

At a minimum, you'll need:

- A transmitter and receiver, or a transceiver (the transmitter and receiver are housed in one cabinet and share common tuning circuits).
- A transmit-receive switch, if you use a separate transmitter and receiver. This allows you to disconnect the receiver from the antenna while you're transmitting.
- An antenna.
- A standing wave ratio (SWR) meter, or watt meter, which gives you an idea of the efficiency of your antenna system – antenna and transmission line – and how well it's matched to your transmitter. If the antenna and transmitter aren't matched properly, much of the energy leaving the transmitter is reflected back into it, instead of radiating from the antenna. If reflected power is too intense, it can damage the transmitter.
- A transmatch, which is a tuning device connected between the transmitter and antenna. In essence, it fools the transmitter into "seeing" a matched condition with the antenna. It also allows hams to use some very unorthodox antennas, including window screens, downspouts, and vertical lamp poles (apartment dwellers take note), as well as highway guardrails.
- A dummy load, basically a mock antenna, which allows you to tune or test your transmitter or transceiver without putting a signal on the air that could interfere with other stations.

An expensive shopping list? It doesn't have to be. It depends on how you approach it. There are two basic avenues for acquiring these and other pieces of equipment. You can buy commercial units. Or you can build your own, either from circuits published in various ham-radio books and magazines, or from professionally engineered kits.

"The key is how much money is available. If you're on a tight budget, look into second-hand equipment. There are some good, early vintage transceivers around for $100 to $150," says Wes Hayward (W7ZOI), a 27-year veteran of the pastime who has written extensively about the hobby. Sources of used equipment can be found through local ham-radio clubs, ham-magazine ads, and ham-club flea markets and auctions. Many of these same sources also can lead you to outlets for new equipment. Experienced ham-radio operators often are very willing to help newcomers select new or used gear.

If you have $500 to $600 to spend, Mr. Hayward adds, there are "nice transceivers made in Japan. Japanese equipment represents very impressive performance per dollar."

Commercial units have several advantages. They can be put on the air almost as soon as you pop open the carton. And if you decide later to purchase a new radio, commercial units generally have a higher resale value. The disadvantage is cost. The price of a new transceiver ranges anywhere from about $400 to $3,000 or more, depending on the number of "bells and whistles" packed into the cabinet.

Building a transmitter or receiver also has advantages. Its resale value may not be great, but a "homemade" radio can get you on the air for less money. And you sure get to know your way around the inside of the cabinet.

"It's very rare to find a radio amateur these days who really understands how his equipment works" or who can repair a radio that breaks down, Mr. Hayward says. "You're really going to learn something about electronics by building your own equipment."

Hayward readily admits his bias. He says he's designed and built most of his own equipment.

Kits offer a compromise between commercial and home-built equipment. The Heathkit Company in Benton Harbor, Mich., is probably the best-known kitmaker in the United States. Prices for its transceiver kits range from about $180 to $700. The firm also markets a transmitter and receiver kit that, combined, sell for about $530 (including the power-supply kit for the transmitter). Heathkit also offers a variety of accessories, including transmatches and SWR meters, in kit form.

Both kits and "homebrew" radios, Hayward says, give the builder "the confidence to get inside the box" when the need arises or when the desire strikes to improve its performance.

Once you've picked a radio, it's time to consider an antenna. This is perhaps the key decision in setting up a station: All other things being equal, your antenna system will determine how effectively you'll be able to communicate with other stations.

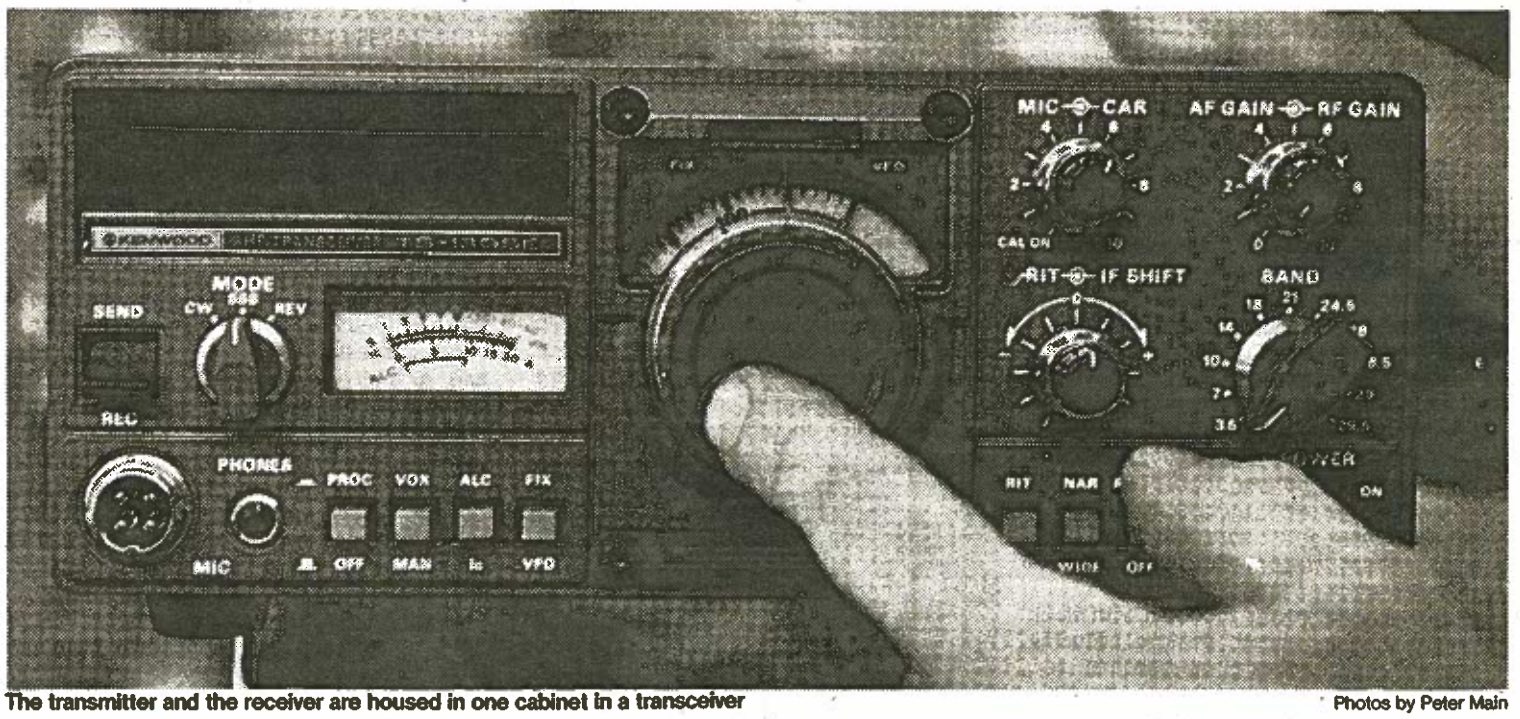
A number of good books geared to beginners is available on the subject. Besides presenting basic antenna theory and construction, many of these books also describe unobtrusive indoor antennas for hams who live in apartments.

Broadly speaking, there are three types of antennas to chose from:

- **Verticals.** Made of aluminum tubing and designed to work on one or more amateur bands, verticals radiate in all directions. In most cases they're self-supporting and stand just under 30 feet tall. Often they're mounted on the ground. If bought ready-made, a vertical can cost from about $30 to $160, depending on quality and design.
- **Wire antennas.** The most common type is the dipole, a length of wire cut for a specific frequency band and strung as high as possible between two supports. The transmission line is attached to the center of the antenna. Depending on the frequency, these antennas can range from about 15 feet to 260 feet long. Different dipoles can be tied to the same transmission line to eliminate the need to switch antennas. Ideally, the dipole radiates best broadside to the wire. Depending on the type of transmission line and supports used, an efficient dipole can be built for $50 or less.
- **Beams.** These are the most sophisticated – and expensive – antennas of the lot. Usually made of aluminum tubes, the beams consist of a boom that supports two or more parallel elements. These elements, also aluminum tubes, run perpendicular to the boom. The advantage of a beam lies in the fact that it's highly directional. This not only substantially cuts unwanted interference from signals hitting the backs and sides of the antenna when receiving. It also concentrates most of a transmitted signal in one direction, thus making more effective use of the power at hand than either of the other two types of antennas. Beams are mounted on metal towers and use antenna rotors to turn them to the desired direction. Depending on design, the cost of commercially made beams range from about $80 to nearly $700. That doesn't include the tower – up to $2,400 – and the cost of the antenna rotor.

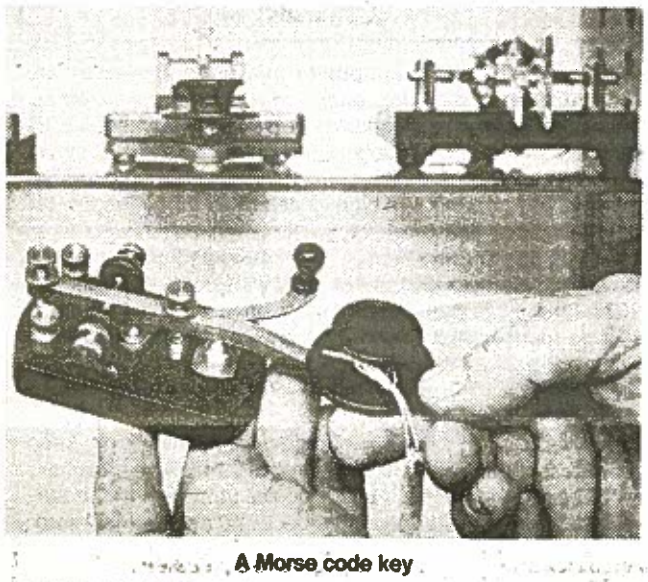
The choice between these antennas may hinge on more than the condition of your pocketbook. Before you spend a dime on an antenna, check with your city or town zoning board, or homeowners' association, to see what, if any, restrictions they place on outdoor antennas.

**Next: installation and operation of your station**

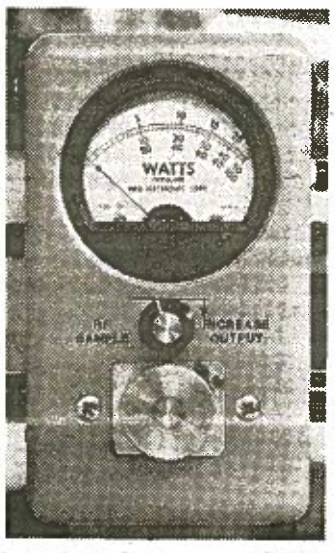



The transmitter and the receiver are housed in one cabinet in a transceiver

Photos by Peter Main



A Morse code key




A watt meter

## Amateur frequencies

**One way to catch the flavor of amateur radio is to tune in the amateur frequencies — a pastime that requires a general coverage shortwave receiver capable of tuning from 2-30 MHz, or a VHF/UHF scanner capable of receiving 144-148 MHz and 420-450 MHz. The following is a partial list of amateur bands. Generally, frequencies for single sideband (SSB) voice communications are found near the high end of each band. Morse code is used toward the low end of each band.**

| Band | Frequency (in megahertz) |
|---|---|
| 160 meters | 1.80-2.00 MHz |
| 80 meters | 3.50-4.00 MHz |
| 40 meters | 7.00-7.30 MHz |
| 30 meters* | 10.050-10.150 Mhz |
| 20 meters | 14.000-14.350 MHz |
| 16 meters† | 18.068-18.168 MHz |
| 15 meters | 21.000-21.450 MHz |
| 12 meters† | 24.890-24.990 MHz |
| 10 meters | 28.000-30.000 MHz |
| 2 meters | 144.000-148.000 MHz |
| 70 cm | 420.000-450.000 MHz |

* Approved for use under 1979 World Administrative Radio Conference (WARC) treaty, this now is available to US amateurs. Meanwhile, 40 other countries have opened this band to their amateurs.

† Approved for amateur use in '79 WARC treaty, but unlikely to be used by amateurs until 1986 or beyond.

# HAM RADIO

## What to do with the shiny new ham gear

*Last of a series on how to become an amateur radio operator.*

By Peter N. Spotts
Staff writer of
The Christian Science Monitor
Boston

Once you've passed the Novice test and decided how you want to equip your station, there are some general points to keep in mind when setting up your gear:

● **Safety:** There should be plenty of electrical outlets, preferably the three-prong grounded outlets. If the room has few outlets, use a commercially made outlet strip at the operating table rather than a nest of extension cord, to bring electricity to your equipment. Parts or circuits carrying any form of electrical current, whether DC, AC, or radio frequency, should be covered to prevent shocks. The voltage and current levels in many pieces of radio equipment are dangerous.

All equipment, from the code key to the transmitter, should be connected to a good ground as a precaution against shocks: Ideally, the equipment should be connected to one or more six-foot ground rods driven into the earth. Use heavy gauge copper wire or strips of copper flashing to make the connections. Short of that, connection to a cold-water pipe will suffice.

Antennas should never be erected near utility power lines, nor should they be erected when a thunderstorm is nearby. To the extent possible, route the antenna transmission line so that it's out of the reach of passersby. The line should have either a lightning arrester or a switch that will let you disconnect your radios and ground the antenna lead when a thunderstorm approaches.

● **Location in the home:** Try to set up the station in a relatively secluded part of your home. This way, you won't disturb others, and they won't disturb you. One good location is in a basement or ground-floor room. These places afford easy access to an earth "ground." Another alternative is an attic: It's closer to the antenna, so the transmission line can be kept short, but it's also farther from an acceptable grounding point.

● **The operating table:** The chief concern here is operator comfort. Equipment should be placed on a shelf high enough so that the tuning dials or displays are at eye level. And there should be enough room to rest your entire forearm on the table when using the telegraph key. There should be plenty of drawer space to store paper, pencils, and station logbooks, which you'll use to record your station activities. One possibility is to use an unfinished door supported at each end by filing cabinets (used ones, if you're a good bargain hunter).

By Peter Main, staff photographer

**QSL cards are exchanged to verify contact between two ham radio stations**

Once your Novice license has arrived and your equiment is hooked up, it's time for the moment of truth: your first contact.

"My first contact? It was kind of exciting and rather scary, confusing. I had trouble figuring out what they were saying and what I was supposed to say," says Stephen K. Sorton, KA0GFA. "But once you make a few contacts, it gets exciting!"

Stephen, whose father has been an amateur radio operator for 27 years, earned his Novice license in 1979 at the age of 12. He upgraded to General class last July.

**To many hams, DXing — contacting foreign countries — holds the most intrigue and excitement.**

"My hands were shaking, I didn't know I could do it," says Tobi Fisher (KA9MMY). "My first few contacts, I told them I was new. They gave me a lot of encouragement."

That's a key point: Don't hesitate to tell other stations you're a newcomer. If the other station is sending code too fast, ask the operator to slow down. It's a more effective way to keep the contact going than if you tell the other station you missed the transmission because of static or interference. This forces the other operator to repeat information — probably at the same speed used before.

Mrs. Fisher adds that it's helpful to have an experienced ham with you the first time you go on the air. In her case, her husband Gary (K9WZB) coached her along.

"Rag-chewing," holding long chats with other stations, is probably the first activity most hams try. But it doesn't take long for rag-chewing to give way to public service work, contesting, and DXing (contacting foreign countries), just to name a few.

To many hams, DXing holds the most intrigue and excitement.

"A contact with a friend in England, G3MFQ, was my first real DX station," says Mrs. Fisher. "Then one day, just out of the blue, I talked to KP2A/KP1, a DXpedition to Navassa Island in the Caribbean! They had just moved into the Novice bands, and I just happened to be there when they put out a call!"

One reason for her enthusiasm — even seasoned DXers' went after the Navassa station with gusto — is that contacts with the island, a speck of land between Haiti and Jamaica, are rare. Only when ham radio operators travel to the island and set up a temporary station there (a DXpedition) can contacts with it be made.

Handling traffic — third-party messages from people all over the country — also is popular. Novice traffic networks often give new operators their first exposure to amateur radio public service work.

Sitting in front of radio gear tucked in a corner of a third-floor bedroom, Jim Hatherly (WA1TBY) tunes around to find the First Region Net, which handles traffic to and from the New England states.

As he zeroes in on the 7:45 p.m. net, the high-pitched staccato of Morse code fills the room. "That's Milt," he says with a grin, on hearing the call sign of a station checking into the net. "He's a retired banker down in Connecticut."

He explains that, in general, nets are organized into four tiers, each covering a broader swath of territory than the previous one. Nets meet according to a strict time sequence, repeated four times a day. At the highest level are the area nets, each covering about one-third of the coast-to-coast distance across the United States and Canada.

According to the latest listing from the American Radio Relay League (ARRL), the national organization for amateur operators, there are 46 Novice nets around the country.

"I've done a little bit of traffic work," says Stephen Sorton. "It's a good way to increase your code speed and meet new people."

One event high on almost every ham's calendar is Field Day, sponsored by the ARRL each June. It's a contest with a serious purpose. Individuals or clubs operate during a weekend, usually from an outdoor site, and try to contact as many other stations as possible. Bonus points are given for, among other things, operating from noncommercial power sources such as diesel generators or solar panels tied to storage batteries. The exercise is designed to test amateur radio operators' ability to operate under emergency conditions. And there's plenty of room in the event for Novices.

While these are just a smattering of the many activities open to new hams, there's one that shouldn't be left out: preparing to upgrade to a higher license class. Once you get beyond the Novice license, you can use voice, radio teletype, satellites, and TV, in addition to code. Once you can roam outside the Novice bands, you'll be exposed to a whole new world of communications. And you'll meet a wide range of new people on the air.

Says Mrs. Fisher, who upgraded to General less than two months after she got her Novice license last February, "My first voice contact as a General was with a fellow in Oregon who has been written up in National Geographic. His farm has some dinosaur relics on it. He was really interesting to talk to!"

***Peter N. Spotts (N1ABS) has been a licensed amateur radio operator since 1977.***

## research notebook

# Earth's primordial molecule?

**By Robert C. Cowen**

Biologists interested in the rise of organic life have been frustrated by a chicken-and-egg-type riddle. Nucleic acids, the carriers of genetic blueprints, determine what proteins a life form makes. But proteins seem necessary to make the nucleic acids themselves. Which came first?

Discovery of a type of nucleic acid that can act without the help of proteins may point a way out of this dilemma.

The research, carried out at the University of Colorado, has captured wide-spread scientific attention since it was reported in the journal Cell in mid-November. For example, molecular biologist Harry Noller of the University of California at Santa Cruz calls it "one of the most exciting discoveries of the decade." It was made by Thomas R. Cech and colleagues Paula J. Grabowski, Daniel E. Gottsching, Kelly Kruger, Julie Sands, and Arthur J. Zaug.

Biologists recognize two classes of nucleic acids — RNA (ribonucleic acid) and DNA (deoxyribonucleic acid). DNA carries the basic genetic information that determines the development and form and, to some extent, the behavior of an organism. However, it cannot itself put that information to work. RNA generally is needed to translate those instructions into the many thousands of proteins that underlie biological activity.

Some proteins, called enzymes, speed biochemical reactions, including the formation of DNA and RNA. Up to now, biochemists have considered enzymes essential for RNA to operate. What Cech and his colleagues have found is a type of RNA that, to some extent, can act alone.

Cech says the RNA can itself act as an enzyme. He calls it a "ribozyme." The Colorado biologists discovered it in a single-celled pond animal — a protozoan called *Tetrahymena thermophila*. At this writing, they do not know if any other organisms use such RNA. However, they are proceeding on the assumption that they have made a fundamental discovery. Noller agrees. He told the journal Science: "Cech's discovery is raising our awareness of what RNA can do. You can be sure there is a great deal more to be discovered."

Cech calls it "a crack in the door." He explains: " We formerly thought that the molecules that do the work inside the cell were enzymes. Now it looks like ribonucleic acid is perhaps capable of doing some of the work too."

Specifically, the *Tetrahymena* RNA molecules can cut out bits of their own substance and splice themselves together again in a manner that implies that they can recombine themselves into new genetic combinations. This has primordial implications. It suggests that, originally, primitive genetic material could get organic life going without the help of protein enzymes.

Cech warns that such speculation is "a big jump to go from the *Tetrahymena* system." Yet he has likened his findings to "discovering the first enzyme." To put it another way, it's like discovering that the ancestor of all chickens didn't come out of an egg after all.

**A Thursday column**

# HAM RADIO

## Getting a Novice license is easier than you'd think

*First of three articles on how to become an amateur radio operator.*

By Peter N. Spotts
Staff writer of
The Christian Science Monitor
Boston

If you're interested in getting a ham radio license but don't think you have the technical background to pass the tests, meet two ham radio operators.

Evelyn I. Fox (WB9QZA) was first licensed as a Novice in 1974, at age 77.

"When I was a little girl," she recalls, "one of my neighbors, a young boy, had a tower with an aerial on it in his mother's garden. He was taking code over the air. It was a very mysterious thing to me, and I always wanted to learn that."

After the death of her husband, she decided to take a license course at a nearby ham radio club.

"I almost didn't go into the class," she says. "There were mostly men, and I was kind of timid. Finally, the instructor's wife said, 'You're in the right place, come on in.' "

"When I started, I didn't know an ohm from a watt!" she adds.

Today, Mrs. Fox holds a Technician-class license, which requires a more thorough knowledge of amateur practice and procedure than does the Novice "ticket."

At the other end of the scale sits Guy Mitchell (WD0DVX), who passed his Novice exam in 1977, just 15 days before his fifth birthday.

"It started with his dad," says Mrs. Mitchell, also a ham radio operator. When he took a license course, she became interested and followed suit.

"Guy would hear me practice the code," she says, "and he caught on real fast." As for boning up for the theory portion of the Novice test, "Guy knew how to read, so a lot was memorization," she says.

Between these extremes lie the hundreds of thousands of amateurs in the United States — many with no background in electronics — who have passed the Morse code and radio theory tests required to get the necessary operating licenses from the Federal Communications Commission.

As if to sweeten the pot, the FCC over the past 10 years has expanded the privileges for holders of Novice licenses — the entry-level classification.

By Peter Main, staff photographer

**Ham magazines are good sources of information for locating study materials**

Under the old regime, the Novice license was valid for one year and couldn't be renewed. Novices were held to a power limit of no more than75 watts going into the final amplifier stage of the transmitter. And transmitter tuning had to be controlled by a crystal, which because of its physical characteristics and the circuits used in Novice transmitters can only be used on one frequency. Thus, if you wanted to operate more than one of the four high-frequency (HF) ham bands, you had to have several crystals.

Today, Novices can use transmitters (with variable-frequency oscillator tuning circuits) that allow them to roam the reaches of the Novice bands at will. Moreover, the Novice ticket is valid for five years, can be renewed, and the power limit has been boosted to 250 watts. (The legal limit for amateurs is 1,000 watts.)

The Novice exam consists of a 20-question, multiple-choice section covering very basic radio practices, procedures, and regulations, and a 10-question fill-in test based on a 5- to 6-minute Morse code message. The message, one side of a typical on-the-air conversation, is sent at five words per minute (w.p.m.).

The Technician license, the next step up, keeps the five w.p.m. code test, but asks 50 questions calling for a more advanced knowledge. The Technician ticket at one time gave its holder broad operating privileges, but only on ham bands above 30 MHz — VHF, UHF, and microwave frequencies. Now Technicians may operate on Novice frequencies as well, giving them access to HF bands.

The Technician license is followed by the General (13 w.p.m. code test and the same theory exam as the Technician), the advanced (13 w.p.m. code test but a tougher, 50-question theory exam), and the Extra (20 w.p.m. code test and the toughest written test this side of Noviceland, but only 40 questions). The passing grade for every exam: 70 percent.

Perhaps the most-used means of boning up for the Novice exam is through classes offered by many local amateur radio clubs.

The American Radio Relay League, the national umbrella organization for ham radio enthusiasts, can provide the names and phone numbers of clubs in your area. The league's address is 225 Main Street, Newington, Conn. 06111. Inquiries should be directed to the Club and Training Department.

The cost of a club education varies. Usually, students pay for books and materials, which often run less than $20. Some clubs charge a nominal registration fee. Classes are also given through high school and community college adult education programs.

One of the main strengths of club courses is the support students get from one another. Mrs. Fox, for example, took her Novice and Technician courses with the Yellow Thunder Amateur Radio Club in Baraboo, Wis.

"I had a little code in the Civil Air Patrol during the war," she said. "The theory, though, was hard for me.

"But the boys were awfully good to me," she adds, in describing how classmates and her instructor helped her over the rough spots.

It's possible to study on your own. A number of books are available that lay the material out in an easy-to-understand manner. A short list of sources for code and theory study material is found elsewhere on this page.

Regardless of how you choose to master the Novice material, it's wise to start learning Morse code as soon as you can. This is the one aspect of the license requirement that seems to meet with the most resistance from students — which is a shame, because code isn't tough to learn.

When taking a Novice course with a club, instructors set aside time for code practice. If you're studying on your own, you can use prerecorded cassette tapes from a number of sources, including the American Radio Relay League. It's also helpful, and fun, to listen to conversations on the Novice bands or to code practice runs broadcast by the league over its station W1AW. Schedules and frequencies for W1AW code practice sessions are available from the league.

The key is learning by sound, not by sight. Don't memorize by looking at a chart of dots and dashes. That adds an additional translation step. You're ultimately trying to respond to the letter (and as you get better, entire words) by writing it down when you hear it, without having to think about it. Gradually, you'll find code changing from halting speech to flowing conversation.

When it comes time to take the test, relax. This is a hobby, remember? There's no real pressure on you. If you've taken a class, your instructor will usually administer the exam. If you've studied on your own, you'll either have to find a ham willing to serve as a volunteer examiner or ask the local FCC office to assign a ham to administer your test. The examiner must hold a General-class license or higher. The code portion comes first. If you pass the code but fail the rest of the exam, you'll get credit for the code portion for a year. You'll only need to retake the theory portion. Those who fail part or all of the test must wait 30 days to retake it.

Earning the license, however, is only the beginning!

**Related story on today's centerspread**

**Next: How to set up your first station**

**Here is a list of sources for Novice class study material (these publishers also offer study material for other amateur radio license levels).**

**Ameco Publishing Company ***
**275 Hillside Ave.**
**Williston Park, NY 11596**

**American Radio Relay League ***
**225 Main St.**
**Newington, CT 06111**

**Bash Educational Services, Inc. ***
**525 Estudillo Ave., Suite B**
**San Leandro, CA 94577**

**Hayden Book Co., Inc. ***
**Rochelle Park, NJ**

**Heath Company ***
**Benton Harbor, MI 49022**

**Howard W. Sams & Co., Inc. ***
**4300 W. 62nd St.**
**Indianapolis, IN 46268**

**Reston Publishing Co., Inc.**
**Reston, VA 22090**

**Tab Books, Inc.**
**Blue Ridge Summit, PA 17214**

*** These sources offer code practice tapes as well as theory texts.**

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